

A New Digital Land Mobile Satellite System

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ABSTRACT

Pressures on the limited spectrum currently available for mobile satellite communications, as well as the progress being made in other areas of advanced telecommunications networks, such as ISDN, provide the driving force for fully digital mobile satellite systems to serve future markets. For example, INMARSAT is in the process of converting its long-established analog Standard-A service into its digital Standard-B service to increase system capacity and reduce the cost of service to users. Other new INMARSAT services, including Standard-C and Standard-M services, as well as aeronautical satellite services, will be digital in nature.

The same is true for coming national services. Although some satellite systems will retain both analog and digital services, such as the one proposed by the American Mobile Satellite Corporation (AMSC), others such as the digital land mobile satellite service (DLMSS), proposed by the Geostar Messaging Corporation (GMC), are dedicated to the use of only digital transmission techniques.

This paper begins with a description of the different digital services planned to be carried over existing and planned mobile satellite systems, and compares them with analog services in terms of bandwidth and power efficiency.

This comparison provides the rationale for the establishment of a DLMSS service to utilize frequencies that are currently available but not yet assigned to a domestic mobile satellite system in the United States. In response to a petition filed by GMC, the FCC has issued a Notice of Proposed Rulemaking (NPRM) for the allocation of additional frequencies for mobile satellite services. GMC currently has an application pending at the FCC for the use of those

frequencies for digital mobile satellite communications, and this paper reviews the status of that DLMSS proceeding.

The paper focuses on the expected advantages of digital transmission techniques in accommodating additional mobile satellite systems in this portion of the spectrum, and how such techniques can fully satisfy voice, data and facsimile mobile communications requirements in a cost-effective manner. It also provides a detailed description of the system architecture of the DLMSS service proposed by GMC, and the market potential which is intended to be addressed by DLMSS.

The final element of this paper will be a discussion of the phased introduction of new mobile satellite services, such as DLMSS. Since future mobile satellite systems are likely to be developed by start-up companies who lack the financial backing of large, entrenched carriers, long-term strategies are needed to guide the development and evolution of such future DLMSS systems by entrepreneurial companies.

INTRODUCTION

The Geostar Messaging Corporation (GMC), a wholly owned subsidiary of the Geostar Corporation, was created to serve the public with a full range of two-way communications services, including facsimile, voice, and full-scale electronic mail.

Geostar currently provides satellite-based positioning, supplemental messaging, and sensor monitoring to a host of commercial and governmental customers through its subsidiary, Geostar Positioning Corporation. Mobile users and operations centers use the patented GEOSTAR[®] System to determine vehicle

positions and to communicate with them quickly and cost-effectively. The heart of the Geostar System is the timely coordination of mobile transceivers using proprietary satellite transponders with the facilities at Geostar Central. Owners of truck fleets in particular have discovered that this service vastly improves efficiency. Mobile assets can be more effectively managed when headquarters has a real-time way to track their positions, receive status reports, and direct their movements.

THE MOVE TOWARD SPECTRUM EFFICIENT SYSTEMS

The limited spectrum available for mobile satellite communications and the development of low cost digital technology for use in communications systems have driven the industry towards all-digital mobile satellite systems. Voice compression devices, initially developed to permit secure voice transmission for government users, are now available to provide high quality speech channels at 9600 bits per second and good quality at 4800 bits per second. Light weight, portable facsimile machines and lap-top computers are now available for use in mobile environments. Terrestrial digital switching and transmission facilities exist everywhere. The next generation of cellular systems will be digital rather than analog, resulting in considerable investment in the development of speech compression, processing and transmission devices that will become available for other uses.

INMARSAT is in the process of converting its long-established Standard-A service into its digital Standard-B service. They will also be offering two other all-digital services, Standard-C, 600 bit per second, and Standard-M, 4800 bit per second.

The initial mobile satellite systems were based on analog FM transmission. The INMARSAT System's Standard-A terminals are in full use for voice and data transmission. Initially, domestic mobile satellite systems considered use of ACSSB transmission to reduce the bandwidth needed for a voice channel, but advances in voice compression technology are encouraging the development of all-digital mobile satellite systems.

In the INMARSAT system, the bandwidth required for a maritime telephone channel has decreased from 30 kHz (50 kHz channel spacing) for its Standard-A service to 8 kHz (10 kHz channel spacing) for its Standard-M service. In its initial application to the Federal Communications Commission, AMSC proposed both ACSSB and digital transmission schemes. AMSC's digital transmissions ranged from a 2400 bit per second emergency voice service using 5 kHz channels up to 16 kilobit per second toll quality service using 20 kHz channels. The latter service appears to be somewhat similar to the INMARSAT Standard-B service.

Although GMC's system will have as much flexibility as those of INMARSAT and AMSC to provide a wide variety of services to its users, GMC has focused its initial system design on providing a 4800 bit per second voice and facsimile service, and a 1200 bit per second data service. These two data rates can accommodate most of the anticipated customer applications of MSS, and can easily be expanded to meet other customer needs. Moreover, such channels can be accommodated within 5 and 7.5 kHz channel spacings.

With GMC's newly proposed Digital Land Mobile Satellite Service (DLMSS), mobile users anywhere within the United States will be able to use GMC's system to communicate directly with other mobile units, and to access newly emerging digital voice and data networks, including facsimile, through simple mobile or portable terminals.

PROPOSED SATELLITE SYSTEM

Geostar's digital mobile satellite communications system will use on-board signal processing and switching techniques. Two high-capacity, dedicated, GMC digital satellites will provide high-quality, reliable digital communications services to mobile stations throughout the United States. Using eight spot beams covering all fifty states, these DLMSS satellites will make maximum use of available spectrum.

In addition to these dedicated, high-capacity satellites, GMC will also construct a lower

capacity, interim DLMSS system carried on board another satellite or on a "Smallsat" to provide an early demonstration of this technology and to provide an early market entry. GMC is currently evaluating various launching alternatives. Interim service may also be provided using leased INMARSAT capacity.

Radio Frequency Plan

GMC's digital mobile satellite system architecture will consist of the following basic elements:

- a space segment operating in the 1.5/1.6/20/30/ GHz bands;
- a master central earth station;
- mobile and portable earth stations directly accessing the space segment;

- multiple ground stations throughout the United States where the satellite system interconnects with terrestrial public data and voice networks;
- a central telemetry, tracking and command earth station.

DLMSS mobile earth stations will use the 1530 - 1544 MHz and 1626.5 - 1645.5 MHz bands (i.e. L-Band frequencies). Control and links from the master control earth station will be implemented using K-Band feeder links (See Figure 1). These frequencies are particularly well-suited for digital land mobile communications from a propagation point of view. In addition, these bands have been allocated internationally in part for digital mobile satellite communications, which make them ideal for the development of this type of satellite system. The on board processing of DLMSS satellites will allow one-hop connections between mobile terminals, as well as flexible and widely distributed access to terrestrial networks.

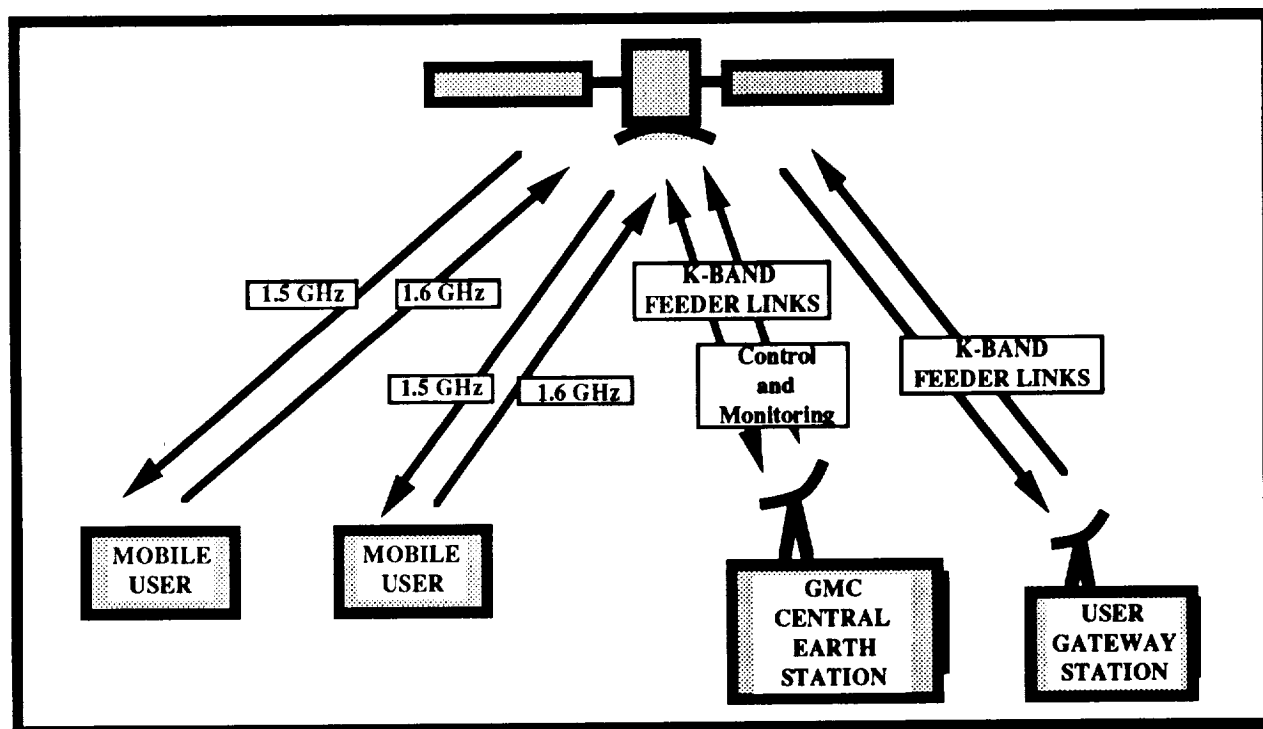


Figure 1. GMC Digital Land Mobile Satellite System

Coverage Areas

One of the principal features of the GMC digital LMSS system will be the use of proven spot beam technology. The system design currently being considered for the digital LMSS system will achieve effective spectrum and orbit utilization by using eight spot beams to cover all 50 states.

The service area will include the contiguous 48 states, Alaska, Hawaii as well as inland waterways, the Great Lakes, and coastal waters adjacent to the United States. It is expected that antenna optimization can be accomplished in such a way as to provide coverage of Puerto Rico and the United States Virgin Islands.

Within this basic service area, GMC will optimize beam parameters and pointing to best match projected traffic distribution within a given area.

System Services

There is a growing demand for a mobile communications system to provide digital communications. GMC will employ user units for portable, in-vehicle and fixed applications, and will provide initial transmission rates between 1200 and 4800 bits per second in order to meet this demand. DLMSS will provide facsimile and communications between personal computers, as well as a digital voice messaging capability. Initial units will be portable or vehicle mounted, and eventually GMC expects to be able to match the miniaturization of current handheld cellular telephone sets in its DLMSS user terminals.

Several general categories of services will be offered initially over the Geostar DLMSS system. Generally, it is expected that all of these services can be provided over any of the DLMSS user terminals.

Digital Data Transmissions. The DLMSS system will provide two-way data communications services, either on a packet switched or circuit switched basis.

Facsimile. Mobile facsimile will be a significant new capability that will be offered over the Geostar DLMSS satellite system. A

mobile facsimile unit can be installed in a car or truck, and transmissions sent to and from that unit, while it is on the road. Such use is expected to add new dimensions to mobile communications. For example, bills of lading can be automatically transmitted to truckers while en route. Documents prepared in the field can be faxed to office headquarters to initiate order servicing. Maps and other graphic materials, such as updated architectural and engineering diagrams, can be easily sent to field workers.

Digital Voice. Although Geostar's mobile satellite system will be optimized for data transmission, recent developments have made it technically and economically possible to encode voice communications into a digital transmission format at transmission rates of 4800 bits per second or less. Geostar is convinced that the signal quality of its digital voice service will be suitable for user applications in the mobile environment. Moreover, as technology advances, the quality of such compressed digital voice transmissions will improve.

Digital Paging and Dispatch. Geostar expects that it will be able to develop handheld mobile units in conjunction with DLMSS equipment manufacturers. This will permit a much greater capability for paging and dispatch services than those currently available from terrestrial paging companies. Such a service offered over a DLMSS satellite would be intrinsically nationwide in nature. While the size of DLMSS paging terminals will be larger than conventional tone and alphanumeric pagers, their two-way transmission capability for acknowledgement and response, together with their high data transmission capability, will make them attractive to many paging customers.

Remote Data Collection and Monitoring. The Geostar DLMSS will support transportable or fixed data terminals for data collection from remote sites. The units will be built to withstand harsh environmental conditions and will be designed for long periods of unattended operation. This service will be particularly useful in security and environmental data collection applications.

Data and Voice Message Store and Forwarding. In many cases, real time two-way or circuit switched communications are not

required, or the called party's line may be busy. In this case, Geostar's DLMSS system will provide users with the capability to store the message at the central earth station for forwarding at a future time when the connection can be completed.

Emergency Data and Voice Communications. DLMSS provides a flexible, efficient means of providing immediate communications for emergency teams operating in areas not served effectively by terrestrial means. Particular situations requiring such communications capabilities include forest fire fighting, medical team operations in remote areas, and disaster response teams. Such emergency situations require both data transmission capabilities, such as for transmission of medical or other telemetered data, and voice communications for effective consultation between the on-site and headquarters personnel responsible for responding to the emergency.

Potential Markets

Automotive. Automobiles are becoming more and more electronically sophisticated. Soon, automobiles will be fitted with complex electronics that will perform increasingly complex tasks. On-board navigation systems have already been announced, and personal computers are likely to be installed in the near future. The Geostar DLMSS system will complement these developments by adding full, two-way digital communications capabilities to the increasingly complex array of electronics options available for installation in automobiles.

The trucking and railroad industries have already begun to install advanced electronics systems for surveillance and control of their operations. The Geostar DLMSS system will further enhance these capabilities.

Lap-top personal computers. As the employment of personal computers for professional and personal use increases, there is a growing need for the ability to access computer resources (i.e. databases and communications networks) when away from the home or office. An integrated lap-top computer/DLMSS terminal will solve this problem. Salesmen in the field will be able to directly enter sales orders into

headquarters computer data bases, and authors can directly transmit manuscript revisions to their agents from retreats in the country. GMC is convinced that the flexibility and low cost of DLMSS will greatly extend access to personal computer resources for professional and individual use.

Maritime. GMC anticipates there will be a growing need for digital communications for both commercial and pleasure vessels on inland waterways, on the Great Lakes, and in coastal waters. Maritime operations are becoming increasingly dependent on sophisticated electronics systems. Moreover, there is an increasing need to be able to transmit significant amounts of data in the maritime environment. Such capabilities will be particularly useful for transmitting the most up-to-date oceanographic and weather charts to highlight changes in navigational conditions, for relay of oceanographic and marine research data, and to ensure efficient commercial maritime operations.

Rural/remote data. The Geostar DLMSS system will provide an economical means for data communications in rural and remote areas. These areas generally lack an effective infrastructure of terrestrial communications facilities.

DLMSS will readily provide high-quality, reliable data and voice capabilities for all of the rural and remote areas of the country, including Alaska. In addition to mobile and transportable applications, DLMSS is ideal to provide a reliable, economical means of two-way digital communications to rugged terminals designed to operate for long periods of unattended operations. Applications include monitoring and control of remote, unmanned facilities and equipment, such as transcontinental pipelines, and collection of environmental, meteorological and hydrographic data from remote sites. A particular value of DLMSS would be the two-way transmission capability which also allows security alarms to be transmitted to the central monitoring site in the event of intrusion or equipment malfunction, and control of interrogation signals to be transmitted to the remote, unattended site.

FEDERAL COMMUNICATIONS COMMISSION

In response to a petition filed by Geostar, the FCC issued a Notice of Proposed Rulemaking (NPRM) on March 5 to allocate additional frequencies for mobile satellite service. Geostar currently has an application before the FCC for a license to construct and operate a DLMSS system using those frequencies. GMC believes that it is the Commission's policy to spur the rapid introduction of new technologies and services that encourage development of competitive, efficient telecommunications services markets. The underlying rationale for the Commission's actions has been the desire to have the American consumer enjoy the full benefits of competitive markets in the choice, quality, and price of telecommunications services, and rely on such markets as a mechanism to support the public interest goals of the Communications Act.

PHASE IN TO FULL SERVICE

Geostar Messaging Corporation, with its DLMSS system, will combine with the RDSS service of Geostar to make the company a full service satellite communications company capable of providing ocean to ocean "seamless" voice, data and position reporting services that no other single entity can match. Unlike terrestrial systems which can be started in local areas with modest investments, a satellite system takes one large investment at the front end to get started and many years to recover the investment. Geostar has therefore developed a phase-in plan to allow the revenues to build as increasingly larger investments are made.

It is important for GMC to get into business by early 1992 to take advantage of the "window of opportunity" that will exist during the next five to seven years because:

- 1) No other U.S. satellite system is now in operation providing voice, facsimile and data services.
- 2) Cellular radio coverage now exists only in the MSA's, i.e., the large metropolitan areas. Most of the country is not covered and will not be for at least five years and possibly ten.

3) Cordless telephone CT-2, and Personal Communications Networks (hand-held cellular) have not yet arrived in the U.S.

4) Facsimile, imaging and digital technology are becoming the accepted method of managing decentralized resources.

The GMC all-digital full voice, facsimile and data two-way communications program is timed to start service in 1992. This can be accomplished by leasing capacity from INMARSAT. GMC will then build a "smallsat" dedicated satellite that can provide an order of magnitude increase in capacity. For the long term a large multi-beam satellite will be required to handle the traffic and provide adequate power. GMC would require that additional capacity in the middle '90s.